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ABSTRACT

A study designed to investigate the relationship between spatial ability and selected social and emotional variables is presented. With the total sample of students in a freshman psychology course, and with the 48 females and 45 males separately, the relationship was investigated between spatial ability and participation in, and enjoyment of, activities requiring spatial thinking; familial influences; self-reliance; parents' careers; or anxiety. Selected second-order combinations of these social-emotional characteristics and spatial ability were also examined. Three major types of spatial ability were investigated: one of spatial orientation and two of analytic spatial ability. The measures were the Shepard-Metzler Rotations Test, Form MA of the Revised Minnesota Paper Form Board Tests, and three tests from the Purdue Spatial Visualization Test Battery. The social-emotional measures were the Spatial Experience Questionnaire and the State-Trait Anxiety Inventory. The major findings for either sex or for one or more spatial tests were that higher spatial scores are associated with greater participation in spatial activities, greater mother influence, greater anxiety, and mothers in non-technical career areas. Main and second-order interaction effects are analyzed. (CM)

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A Paper
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of the
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by

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THE RELATIONSHIP BETWEEN SPATIAL ABILITIES AND SOCIAL-EMOTIONAL FACTORS

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The conditions underlying observed differences in spatial ability are open to question. Most studies conducted in the area address themselves to the differences found between females and males. Sizeable sex differences in spatial ability, in favor of males, have been widely documented (e.g., Maccoby & Jacklin, 1974). Several possible explanations for these between-sex differences have been offered, including genetic and neurological factors (e.g., Harris, 1978). Very little work in spatial ability has been directed toward investigating within-sex differences and exploring social and emotional variables which might impinge on the development of spatial skills. The potential influence of social-emotional factors on spatial abilities has been advanced for many years (e.g., Sherman, 1967; Spearman, 1927). In response to the need for research in the area, the present study was designed to systematically investigate the relationship between spatial ability and selected social and emotional variables in a sample of females and males.

Research Questions

For the total sample of subjects and for the females and males separately, this study sought the answers to the

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following questions:

1. Is there a relationship between spatial ability and participation in activities requiring spatial thinking, enjoyment of activities requiring spatial thinking, familial influence, self-reliance, parents' careers, or anxiety?
2. Are selected second-order combinations of participation, enjoyment, familial influence, self-reliance, parents' careers, and anxiety related to spatial ability?

In pursuing these questions, this research was exploratory in nature. Direct studies of the relationship between spatial ability and the selected social-emotional factors, for the most part, are completely absent from the literature. For example, a study by Hartlage (1970) used spatial test data from families, but the study focused on genetic hypotheses rather than on social effects. The lack of direct studies and theory in the area meant that formal hypotheses were not posited for the many statistical tests conducted.

The exploratory function of this study was also served by the comprehensive examination of the spatial ability variable. The existence of three major types of spatial ability, i.e., spatial visualization, spatial orientation, and analytic spatial, is well documented (e.g., Smith, 1964). In this study, two tests of spatial visualization ability, one

test of spatial orientation ability, and two tests of analytic spatial ability were employed.

Subjects

The subjects were 93 students enrolled in a required freshman psychology course at Purdue University. These students included 48 females and 45 males. Approximately two-thirds of each sex group were enrolled in non-technical academic programs (e.g., sociology) and one-third in technical programs (e.g., mechanical engineering). The students volunteered for the study and were paid for their participation.

Procedure

Five measures of spatial ability were obtained in this study. The five spatial tests used were the Shepard-Metzler Rotations Test (S-M)(Shepard & Metzler, 1971), Form MA of the Revised Minnesota Paper Form Board Test (MPFB)(Likert & Quasha, 1970), Visualization of Developments Test (DEV), Visualization of Rotations Test (ROT), and the Visualization of Views Test (VIEW). The latter three tests are from the Purdue Spatial Visualization Test Battery (Guay, 1977).

The selection of the five spatial tests was based on the findings of a study by Guay, McDaniel, and Angelo (1978). The study reviewed 31 tests purporting to measure spatial ability. The S-M and ROT tests were found in the study to be good measures of spatial visualization ability, the VIEW Test a good measure of spatial orientation ability, and the MPFB and DEV tests good measures of analytic spatial ability.

Ten social-emotional measures were also obtained in this study. These measures were participation in and enjoyment of activities requiring spatial thinking, familial influence (i.e., father influence, mother influence, and sibling influence), self-reliance, parents' careers (i.e., father's career and mother's career), and anxiety (i.e., trait anxiety and state anxiety). Data on participation, enjoyment, familial influence, self-reliance, and parents' careers were collected using the Spatial Experience Questionnaire (McDaniel, Guay, Ball, & Kolloff, 1978). Measures of trait and state anxiety were obtained from the State-Trait Anxiety Inventory (Spielberger, Gorsuch, & Lushene, 1970). An overall measure of anxiety was also examined in this study. This overall anxiety variable was defined as the sum of the trait and state anxiety scale scores.

Two one-hour sessions were used to collect the spatial ability and social-emotional data. The first session was used to administer the S-M Test, MPFB Test, and the Spatial Experience Questionnaire. The second session was used to administer the DEV Test, ROT Test, and VIEW Test. Since both sessions were conducted with groups of no more than 20 students, these sessions were repeated to accommodate the 93 subjects of this study.

The State-Trait Anxiety Inventory was administered in another study being conducted concurrently and independently

of this study. Trait and state anxiety data were obtained from this other study for 32 of the 93 subjects. These 32 students included 19 females and 13 males.

Results and Conclusions

Participation, mother influence, mother's career, and the three anxiety variables were found to be significantly related to one or more of the five measures of spatial test performance. Analysis of selected two-factor interaction effects revealed some significant results primarily for interactions of familial influence with the variables participation and enjoyment. Many more significant findings were observed for the female group than for the male group. The significant results for the female group also did not overlap with the significant results for the male group.

These findings are from tests for main effects and second-order interaction effects conducted with multiple linear regression procedures. Separate analyses were run for each of the five measures of spatial ability and for the total group, female group, and male group. The results of the analyses for the total group are summarized in Table 1. Tables 2 and 3 summarize the findings for the females and males, respectively.

The main effects of sex on spatial test performance were also evaluated in this study because of their implications for interpreting the results presented in the tables. The

Table 1

F Ratios for Main and Selected Two-Factor Interaction Effects on Spatial Test Performance for the Total Sample

Source of Variation	Spatial Test				
	ROT	S-M	VIEW	DEV	MPFB
Main Effects					
Participation (P)	.85	.01	.42	3.66	2.00
Enjoyment (E)	.14	.64	1.25	2.22	3.34
Father Influence (FI)	.41	1.10	.23	.04	.18
Mother Influence (MI)	.19	2.76	2.13	3.80	.95
Sibling Influence (SI)	2.06	.01	.90	.36	.01
Self-reliance (SR)	1.18	.02	.00	.45	.11
Father Career (FC)	1.49	1.64	.55	.00	.03
Mother Career (MC)	.34	3.96*	2.52	.05	2.75
Trait Anxiety (TA)	6.33*	7.52**	5.53*	3.70	.23
State Anxiety (SA)	5.45*	7.24*	8.52**	8.63**	3.85
Anxiety (A)	6.57*	8.31**	7.82**	6.56*	1.63
Two-Way Interaction Effects					
P/E	1.33	.01	.46	3.10	.00
P/FI	.20	1.25	.83	.01	1.16
P/MI	.23	.00	.02	3.86	.87
P/SI	.83	.18	.04	.06	.05
P/SR	1.40	.10	.37	2.21	.87
P/FC	2.90	2.40	1.58	1.74	2.89
P/MC	.79	.26	2.48	56	.80
E/FI	1.22	.05	.10	.00	.12
E/MI	.06	.60	.02	2.32	.00
E/SI	3.49	1.09	.27	.41	.20
E/SR	.05	.03	.14	.97	.05
E/FC	.27	.25	1.76	1.57	.61
E/MC	.29	.09	2.19	.06	1.27
FI/FC	.03	3.56	.01	.41	.01
MI/MC	.26	.32	3.24	.04	2.52
P/A	.04	.08	.47	.17	1.30
E/A	.34	.38	.05	.22	2.02
FI/A	.37	.27	3.49	.09	2.14
MI/A	.17	.25	5.00*	.18	.25
SR/A	.00	.20	.19	.18	.33

*$p < .05$.

**$p < .01$.

Table 2

F Ratios for Mean and Selected Two-Factor Interaction Effects on Spatial Test Performance for Females

Source of Variation	Spatial Test				
	ROT	S-M	VIEW	DEV	MPFB
Main Effects					
Participation (P)	1.03	.04	1.32	1.14	.32
Enjoyment (E)	2.53	1.20	.02	3.80	1.17
Father Influence (FI)	.00	.21	.41	.01	.06
Mother Influence (MI)	.01	.39	.00	.86	4.15*
Sibling Influence (SI)	.40	2.23	.26	.32	2.20
Self-reliance (SR)	.11	.83	.68	.11	.04
Father Career (FC)	.90	1.68	.43	.05	.31
Mother Career (MC)	.09	2.40	4.54*	.04	.03
Trait Anxiety (TA)	1.10	4.72*	5.60*	.83	.06
State Anxiety (SA)	.31	2.56	6.22*	4.06	1.81
Anxiety (A)	.74	4.14	6.99*	2.29	.65
Two-Way Interaction Effects					
P/E	.45	.15	.38	.15	.33
P/FI	.00	.45	.22	1.60	.40
P/MI	.02	2.04	.00	8.62**	.12
P/SI	3.83	5.51*	4.96*	.18	.07
P/SR	2.03	5.04*	.58	.10	.09
P/FC	.35	1.16	.06	4.94*	.04
P/MC	.69	3.32	.71	.08	.21
E/FI	4.27*	.24	1.41	.14	.00
E/MI	.01	.09	.05	5.15*	.10
E/SI	3.85	5.75*	3.60	.47	.32
E/SR	.05	.00	.07	.56	.36
E/FC	.17	.20	.89	7.72**	.00
E/MC	.33	3.13	.47	.01	.12
FI/FC	3.14	.14	3.76	.95	.12
MI/MC	.09	2.29	.22	.05	.07
P/A	.17	1.02	.37	.03	.26
E/A	.01	.23	.30	.14	.01
FI/A	.09	.03	.23	.40	.39
MI/A	.01	.06	4.38	.25	.10
SR/A	.08	.81	2.98	.20	.13

*$p < .05$.

**$p < .01$.

Table 3

F Ratios for Main and Selected Two-Factor Interaction Effects on Spatial Test Performance for Males

Source of Variation	Spatial Test				
	ROT	S-M	VIEW	DEV	MPFB
Main Effects					
Participation (P)	1.13	.06	.62	5.28*	2.20
Enjoyment (E)	.22	.50	.62	2.54	2.67
Father Influence (FI)	.65	.33	1.44	.46	.13
Mother Influence (MI)	1.15	.33	1.68	1.06	.33
Sibling Influence (SI)	2.74	1.70	.69	.08	2.27
Self-reliance (SR)	.92	.00	1.36	.90	.07
Father Career (FC)	1.25	.73	.14	.02	.55
Mother Career (MC)	.46	2.91	.11	.21	4.32*
Trait Anxiety (TA)	2.01	.61	.10	.05	1.21
State Anxiety (SA)	2.30	1.05	1.03	.49	5.68*
Anxiety (A)	2.40	.92	.53	.25	3.38
Two-Way Interaction Effects					
P/E	.95	.28	.10	2.84	.06
P/FI	.04	.96	.04	2.18	7.32**
P/MI	.40	1.81	.81	.01	.19
P/SI	.89	.26	.19	.01	1.00
P/SR	.97	.88	.28	.67	1.28
P/FC	5.46*	1.58	3.13	.02	5.23*
P/MC	.18	2.81	.02	.00	3.09
E/FI	1.07	.04	.36	.01	.01
E/MI	1.39	.06	.24	.04	.20
E/SI	2.47	.07	.64	.39	.12
E/SR	.65	.27	.25	.02	.00
E/FC	.55	.08	.33	1.40	.36
E/MC	.38	3.25	.18	.09	3.70
FI/FC	.24	1.64	1.72	.57	.00
MI/MC	1.31	2.50	.02	.01	.72
P/A	.11	3.77	.18	.81	2.34
E/A	1.71	.31	.29	.03	4.80
FI/A	.13	.66	2.08	.01	3.24
MI/A	.01	.04	1.39	.05	9.42*
SR/A	.97	.08	.01	.01	1.02

*$p < .05$.

**$p < .01$.

data indicated that the 45 males scored significantly ($p < .001$) higher than the 48 females on the ROT, S-M, VIEW, and DEV tests. No significant between-sex differences were found for the MPFB Test.

The major findings of this study for either the male or female group or for one or more spatial tests were that higher spatial scores are associated with greater participation, greater mother influence, greater anxiety, and with mothers who have careers in non-technical areas. Other major findings were that higher spatial test scores are associated with the combined effects of greater participation/greater familial influence and greater enjoyment/greater familial influence.

Overall, the results suggest that some of the social-emotional factors examined in this study may help explain individual differences in spatial ability. The findings also suggest that the influence of social-emotional variables on the development of spatial ability may be different for females and males.

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